

The opinion in support of the decision being entered today was not written for publication and is not binding precedent of the Board.

Paper No. 49

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte DONALD R. HUFFMAN
and WOLFGANG KRATSCHMER

Appeal No. 2002-1077
Application No. 08/236,933

MAILED

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PAUL & TITIEN OFFICE
BOARD OF PATENT APPEALS
AND INTERFERENCES

ON BRIEF

Before KIMLIN, GARRIS and HANLON, Administrative Patent Judges.

HANLON, Administrative Patent Judge.

DECISION ON APPEAL

This is a decision on an appeal under 35 U.S.C. § 134 from the final rejection of claims 45-49, 51-84, 96, 181 and 203-248, all of the claims pending in the application. The claims on appeal are directed to a process for preparing fullerenes, specifically C₆₀.

Appellants describe the background of the claimed invention as follows (Specification, pp. 1-2):

This invention relates to new forms of carbon as well as methods for the production and recovery thereof from carbon sources.

In 1985, Kroto et al. postulated the existence of a highly stable molecule composed of 60 carbon atoms based solely on mass spectroscopic analysis of vaporized graphite However, Kroto et al. did not isolate any of said compound.

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A model for this compound was proposed in which 60 carbon atoms are placed at the vertices of a truncated icosahedron forming a perfect "soccerball" structure. Subsequent thereto, many publications have strengthened the evidence for the existence of this molecule. The 60 carbon atom compound (hereinafter C₆₀) was presumably produced *in situ* for the spectroscopic determination reported in these publications. Yet, to date, no one has been successful in verifying the existence of this molecule since no one has been successful in isolating the molecule in measureable amounts. Thus, no processes for producing recoverable amounts of this new compound have been described to the present time. . . .

Another form of carbon containing 70 carbon atoms (C₇₀) has also been postulated Like the (C₆₀) to date, no one has been successful in verifying the existence of the C₇₀. Heretofore, no one has been successful in obtaining the molecule in any appreciable amounts. . . .

A process has now been developed for the production of recoverable amounts of C₆₀ and C₇₀. The present new process is accomplished by evaporating carbon rods in an atmosphere of an inert quenching gas maintained at reduced pressure in a reactor therefor. This process produces a sooty carbon product which is graphitic carbon including a few percent of C₆₀ and low levels of C₇₀ which are recoverable from the product. . . .

The recovery process is preferably accomplished by selective extraction of C₆₀ and C₇₀ with non-polar organic solvents from the sooty graphitic carbon.

Claim 45 is illustrative of the subject matter on appeal and reads as follows:¹

45. A process for preparing C₆₀ comprising:

- (a) vaporizing elemental carbon in the presence of an inert quenching gas under conditions effective to form a sooty carbon product comprising C₆₀ molecules, said C₆₀ molecules being present in said sooty carbon product in amounts capable of extracting therefrom said C₆₀ in macroscopic amounts and in solid form; and
- (b) extracting C₆₀ in macroscopic amounts from said sooty carbon product.

¹We note that appellants incorrectly copied claim 45 in Appendix A of the appeal brief. A corrected copy of claim 45 has been reproduced in this Decision on Appeal.

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Rejections on appeal

In the final rejection, the claims were rejected under several grounds. Claims 45-49, 51-84, 96, 181 and 203-248 were rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicants regard as their invention.² First, the examiner argued that in claims 45, 181, 233, 234, and the claims dependent therefrom "it is unclear how much constitutes amounts capable of being extracted in 'solid' form." Second, the examiner indicated that in claims 83, 84 and 222 the scope of "amounts (or quantities) (of C60) sufficient to be capable of producing a . . . colored solution when extracted with sufficient (or effective) amounts of benzene" is unclear.³ Finally, the examiner argued that in claim 234 and the claims dependent therefrom the scope of "discernible" is unclear. Paper No. 40, pp. 2-3.

²The examiner did not list claim 45 as rejected under 35 U.S.C. § 112, second paragraph, in the final rejection. However, the examiner did discuss the claim in the body of the rejection, and in the brief, appellants indicate that claim 45 is taken as rejected under 35 U.S.C. § 112, second paragraph. See Paper No. 40, p. 2; Brief, p. 16. Therefore, we agree with the examiner that the omission of claim 45 from the statement of the rejection in the final Office action was an obvious error, and we have corrected it here. See Answer, p. 3.

³In the final rejection, the examiner indicated that the scope of claims 83, 84 and 22 (rather than claim 222) is unclear. See Paper No. 40, p. 3. It is apparent on this record that the reference to claim "22" was a typographical error. Compare Paper No. 40, p. 3 (referring to claims 83, 84 and 22) with Paper No. 33, pp. 2-3 (referring to claims 83, 84 and 222); see also Brief, p. 20 (addressing the rejection of claims 83, 84 and 222 under 35 U.S.C. § 112, second paragraph). Therefore, we have corrected this obvious error.

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In the answer, the examiner indicates that the rejections based on "solid" and "discernible" are withdrawn. Answer, p. 3. Therefore, the rejection of claims 45, 181, 233, 234 and the claims dependent therefrom under 35 U.S.C. § 112, second paragraph, is considered withdrawn, and claims 83, 84 and 222 are the only claims which remain rejected under 35 U.S.C. § 112, second paragraph.

Claims 45-49, 51-84, 96, 181 and 203-248 were provisionally rejected under the judicially created doctrine of obviousness-type double patenting. Appellants filed a terminal disclaimer (Paper No. 47) and a response requesting withdrawal of the double patenting rejection (Paper No. 46) with their brief. The examiner did not maintain the double patenting rejection in the answer. Therefore, the double patenting rejection is considered withdrawn.

Finally, claims 45-49, 51-82, 96, 203 and 232 were rejected under the written description and enablement requirements of 35 U.S.C. § 112, first paragraph. These rejections still stand.

Therefore, the following rejections remain at issue in this appeal:

- (1) Claims 83, 84 and 222 are rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicants regard as the invention.
- (2) Claims 45-49, 51-82, 96, 203 and 232 are rejected under 35 U.S.C. § 112, first paragraph, based on written description.
- (3) Claims 45-49, 51-82, 96, 203 and 232 are rejected under 35 U.S.C. § 112, first paragraph, based on enablement.

Grouping of claims

According to appellants, the claims in each group (rejections (1), (2) and (3) identified above) stand or fall together. Brief, p. 15. Therefore, for purposes of appeal, claims 84 and 222 stand or fall with the patentability of claim 83 as to the rejection under 35 U.S.C. § 112, second paragraph. Claims 46-49, 51-82, 96, 203 and 232 stand or fall with the patentability of claim 45 as to the rejection under 35 U.S.C. § 112, first paragraph, based on written description, and the rejection under 35 U.S.C. § 112, first paragraph, based on enablement. See 37 CFR § 1.192(c)(7) (2001); see also 37 CFR § 41.67 (c)(vii) (2004).

Discussion

1. Rejection under 35 U.S.C. § 112, first paragraph, based on written description

Claims 45-49, 51-82, 96, 203 and 232 are rejected under 35 U.S.C. § 112, first paragraph, based on written description. The examiner argues that the disclosure of the application, as originally filed, does not provide descriptive support for the term "macroscopic," and more specifically, does not provide descriptive support for preparing macroscopic amounts of C₆₀ using the claimed process. To support this rejection, the examiner relies on pages 30 through 36 of the Final Decision (Paper No. 84⁴) in Interference No. 103,281. Answer, p. 5.

The test for determining compliance with the written description of 35 U.S.C. § 112, first paragraph, is whether the disclosure of the application as originally filed would have reasonably

⁴The examiner incorrectly identifies the Final Decision in Interference No. 103,281 as Paper No. 88. See Answer, p. 5, lines 3-5.

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conveyed to one of ordinary skill in the art that the inventor had possession of the later claimed subject matter. Vas-Cath, Inc. v. Mahurkar, 935 F.2d 1555, 1563, 19 USPQ2d 1111, 1116 (Fed. Cir. 1991). Initially, we note that the disclosure of Application 08/236,933, as originally filed, does not provide ipsis verbis support for either "macroscopic" or "macroscopic amount." However, the subject matter of the claims need not be described identically or literally for the application to satisfy the written description requirement of 35 U.S.C. § 112, first paragraph. In re Kaslow, 707 F.2d 1366, 1375, 217 USPQ 1089, 1096 (Fed. Cir. 1983). Nevertheless, the description must be sufficiently clear that one of ordinary skill in the art would have recognized from the disclosure that the applicants invented the later claimed subject matter. In re Wertheim, 541 F.2d 257, 262, 191 USPQ 90, 96 (CCPA 1976).

We begin our analysis of the rejection by determining the meaning of "macroscopic" and "macroscopic amount." Appellants do not define either term in their specification. Nevertheless, we can determine the ordinary meaning of "macroscopic" from the dictionary. See Texas Digital Sys. Inc. v. Telegenix Inc., 308 F.3d 1193, 1202, 64 USPQ2d 1812, 1818 (Fed. Cir. 2002) ("unless compelled otherwise, a court will give a claim term the full range of its ordinary meaning as understood by persons skilled in the relevant art").

According to Hackh's Chemical Dictionary 400 (4th ed. 1969) (copy attached), the term "macroscopic" is defined as, "Describing objects visible to the naked eye. Cf. *microscopic*." Similarly, The American Heritage Dictionary of the English Language, 781 (William Morris ed., New College ed. 1976) (copy attached), defines "macroscopic" as:

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1. Large enough to be perceived or examined without instrumentation, especially as by the unaided eye.
2. Pertaining to observations made without magnifying instruments, especially as by the unaided eye.

Therefore, it is reasonable to conclude that the ordinary meaning of "macroscopic amount" is an amount visible to the naked eye, that is, visible without the aid of a microscope.

As pointed out above, the original disclosure of Application 08/236,933 does not provide ipsis verbis support for the term "macroscopic." Furthermore, the original disclosure does not describe that macroscopic amounts of C₆₀ are actually prepared by the claimed process.

For example, on page 11, lines 30 through 32 of the specification, Figure 3 is described as a transmission spectrum of "an approximately 2 micrometer thick C₆₀ coating on a silicon substrate,"⁵ and on page 3, lines 19 through 21 of the specification, Figure 4 is described as a visible-ultraviolet absorption spectrum of "an approximately 0.1 micrometer thick coating of the 98% C₆₀, 2% C₇₀ material on quartz." We take official notice that the human eye cannot detect a thickness of 0.1 micrometer or 2 micrometers without the aid of a microscope. See In re Ahlert, 424 F.2d 1088, 1091, 165 USPQ 418, 420 (CCPA 1970) ("Patent Office appellate tribunals, where it is found necessary, may take notice of facts beyond the record which, while not generally notorious, are capable of such instant and unquestionable demonstration as to defy dispute").

⁵According to the section of the specification entitled "DESCRIPTION OF THE FIGURES," Figure 3 is an infrared absorption spectrum of "an approximately 2 micrometer thick coating of the 98% C₆₀, 2% C₇₀ material on a silicon substrate, referenced to a clean silicon substrate." Specification, p. 3, lines 12-15.

Furthermore, on page 11, lines 24 through 29 of the specification, coatings of C₆₀ are described as comprising "sub-micron microcrystalline particles of solid C₆₀." Suffice it to say that "sub-micron" particles would not be expected to be visible to the naked eye. Thus, "sub-micron microcrystalline particles of solid C₆₀" cannot be said to be "macroscopic" in the ordinary sense of the term.

On page 7, lines 2 though 25 of their specification, appellants describe how fullerenes are obtained by vaporizing graphite according to the disclosed process. Specifically, they state:

The electrical heating vaporizes the constricted tip of the graphite rod producing a high density vapor of carbon, which quickly condenses into a smoke consisting of very fine particles (of the order of 0.1 microns) of graphitic carbon with an admixture of a few percent of the desired C₆₀ molecule.^[6] At this point in the process there is a heavy black coating on collecting substrates and/or on the walls of the chamber which can be easily scraped off for the recovery step.

For recovery, the sooty product is treated with benzene to provide a brownish-red solution. After separation of the undissolved graphitic carbon, the benzene solution is evaporated to obtain microcrystalline product. Alternatively, the product can be sublimed from the sooty carbon at 300° to 400°C. and the sublimation product obtained by condensation on a conventional substrate.

When the pressure of inert quenching gas is 100 torr, the product formed is 98% C₆₀ and 2% C₇₀. This product, as obtained from the solvent extract of the sooty graphitic carbon, is a dark brown to black crystalline material. When obtained by sublimation in vacuum or inert atmosphere, the product is obtained as a brown to gray coating depending on thickness. [Emphasis added.]

⁶We take official notice that the human eye cannot detect a particle 0.1 micron in size without the aid of a microscope.

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Thus, a "microcrystalline" product, described as 98% C₆₀ and 2% C₇₀, is formed by the disclosed process. However, the specification fails to disclose the amount of "microcrystalline" product formed.

Appellants argue that one could not determine the color of the benzene solution unless C₆₀ was present in amounts visible to the naked eye, i.e., present in macroscopic amounts. Brief, p. 23. Although the reaction itself appears to be visible to the naked eye, appellants have failed to produce any evidence which establishes that a macroscopic amount of C₆₀ is required to turn the benzene solution the desired color. See In re Schulze, 346 F.2d 600, 602, 145 USPQ 716, 718 (CCPA 1965) (arguments in the brief do not take the place of evidence in the record). Moreover, the issue is not what is in the benzene solution, the issue is whether macroscopic amounts of C₆₀ were extracted from that solution.

Noting that the product produced after evaporation of the benzene solution can be either a dark brown to black crystalline material or a brown to gray coating depending on its thickness, appellants further argue that such characteristics, especially color, can only be discernible if the material is present in macroscopic amounts. Brief, p. 24. To the contrary, a microscopic amount of C₆₀ can also be observed as a colored crystalline material or a colored coating with the aid of a microscope.

For instance, on page 8, lines 7 through 16 of the specification, appellants describe crystalline C₆₀ produced by the disclosed process as follows:

Studies by optical microscopy of the C₆₀ material which is left after evaporating the benzene solution show a variety of what appear to be crystals -- mainly rods, platelets, and star-like flakes. Figure 1 shows a micro-photograph of such a crystal assemblage. All crystals tend to exhibit six-fold symmetry. In transmitted light they appear red to brown in color; in reflected light the larger crystals have a metallic appearance, whereas the platelets show interference colors consistent with an index of refraction of about 2.

Clearly, a microscope is required to see the colored crystals depicted in Figure 1.

Furthermore, Example 1 on page 16 of the specification describes a "C₆₀-containing carbon dust" prepared by evaporating graphite rods in a helium atmosphere of up to 400 torr. The product, an unidentified amount of "C₆₀-containing carbon dust," was scraped from unidentified substrates and the internal surfaces of the reaction chamber. That product was worked-up by washing the dust with ether and subsequently extracting the previously ether-washed dust with benzene. Evaporation of the benzene solution yielded an unidentified amount of C₆₀ as a "microcrystalline residue." The crystals were sublimed and collected on a substrate. The sublimed product was brown to gray in color, and in powder form, it is brownish-red.

Again, appellants argue that isolation of the product as a powder combined with the fact that the powder is colored connotes that the product could be seen with the naked eye. Brief, p. 23. However, a microscopic amount of C₆₀ can also be observed as a colored powder, albeit with the aid of a microscope. Significantly, the issue is not whether macroscopic amounts of C₆₀ could have been produced by the disclosed process, the issue is whether the disclosure of appellants' application, as originally filed, is sufficiently clear that one of ordinary skill in the art would have recognized from the disclosure that appellants were in possession of a process for

producing macroscopic amounts of C₆₀ at the time the application was filed. Vas-Cath, 935 F.2d at 1563, 19 USPQ2d at 1116; Wertheim, 541 F.2d at 262, 191 USPQ at 96; In re Ruschig, 379 F.2d 990, 996, 154 USPQ 118, 123 (CCPA 1967).

Similarly, example 3 on page 18 of the specification sheds little light on whether appellants were in possession of a process for preparing macroscopic amounts of C₆₀ at the time their application was filed. Example 3 is described as a method for obtaining “[p]ure C₆₀ and pure C₇₀. ” The method comprises dissolving the mixtures obtained from either Example 1 or 2 in benzene. Thereafter, the C₆₀- and C₇₀- containing benzene mixture is added to an alumina column for elution using benzene as the eluent, and the fractions collected are evaporated to dryness. Appellants state that the presence of C₆₀ and C₇₀ in the fraction “can be determined by taking mass spectroscopy thereof.” No yield data for either C₆₀ or C₇₀ is reported.

Finally, at page 1, lines 25 through 30 of their specification, appellants, discussing the prior art, state:

Yet, to date, no one has been successful in verifying the existence of this molecule [(C₆₀)] since no one has been successful in isolating the molecule in measurable amounts. Thus, no processes for producing recoverable amounts of this new compound have been described to the present time. [Emphasis added.]

Furthermore, discussing prior attempts to uncover C₇₀, appellants state (Specification, p. 2, lines 10-13):

Like the (C₆₀) to date, no one has been successful in verifying the existence of the C₇₀. Heretofore, no one has been successful in obtaining the molecule in any appreciable amounts. [Emphasis added.]

Appellants argue that this passage implies that they were successful in achieving this goal, i.e., obtaining C₆₀ in appreciable amounts. According to appellants, "appreciable" by definition means "enough to be perceived." Therefore, "appreciable" connotes a large quantity and is consistent with the term "macroscopic." Brief, p. 24.

We do not find a nexus between "macroscopic amount" and "appreciable amounts." Likewise, we do not find a nexus between "macroscopic amount" and "measureable amounts." Suffice it to say that a microscopic amount of a product is capable of being appreciated, perceived or measured by any number of well-known techniques.

Appellants also describe their process as producing "recoverable amounts" of C₆₀ and C₇₀. See Specification, p. 2, lines 17-18. However, we cannot determine from this disclosure whether the "recoverable" amounts of C₆₀ and C₇₀ produced are "macroscopic."

Specifically, the product prepared by the disclosed process is described as (Specification, p. 2, lines 22-24):

[A] sooty carbon product which is graphitic carbon including a few percent of C₆₀ and low levels of C₇₀ which are recoverable from the product.

We find this disclosure to mean that from an unidentified amount of "graphitic carbon" appellants obtain a small amount of, but more than one percent of, C₆₀ and even less C₇₀, based on the amount of "graphitic carbon" obtained. In any event, the amounts of C₆₀ and C₇₀ produced are not identified.

Appellants also rely on a "Declaration of Harold W. Kroto under 37 CFR §1.132" dated June 9, 1995, and a "Supplemental Declaration of Harold W. Kroto under 37 CFR §1.132" dated November 16, 1999, to support the argument that their original disclosure describes a process for preparing macroscopic amounts of C₆₀. See Brief, pp. 24-29. In the declaration dated June 9, 1995, Dr. Kroto states:

3. The application teaches in clear detail to the skilled artisan the preparation of fullerenes, including C₆₀, in quantities that were never recognizably achieved before the discovery by Huffman and Kratschmer described in the application. Specifically, the application describes methods for the production of C₆₀ and C₇₀ in macroscopic amounts, i.e., amounts that could be seen with the naked eye (inherently at least 10¹⁸ molecules of product). . . .

* * * * *

14. I further assert that the term "macroscopic" aptly and correctly characterizes the breakthrough made by Huffman and Kratschmer in permitting isolation and characterization of the fullerenes C₆₀ and C₇₀, in that the term expressly denotes that which can be seen (and therefore tested); that usage is consistently employed in my papers and reviews on the subject entirely independently of Huffman and Kratschmer.

15. In my professional judgement, the above-identified application adequately teaches to the skilled artisan how to make macroscopic amounts of the fullerenes including C₆₀ and C₇₀; furthermore, there is ample evidence in the application that Huffman and Kratschmer had in their possession macroscopic amounts of these products.

Significantly, Dr. Kroto fails to provide a factual basis for his opinion that appellants' original disclosure provides descriptive support for a process wherein macroscopic amounts of C₆₀ are produced. Therefore, the declaration fails in its purpose. See In re Brandstadter, 484 F.2d 1395, 1406, 179 USPQ 286, 292 (CCPA 1973) ("the affidavits fail in their purpose since

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they recite conclusions and few facts to buttress said conclusions"); see also Rohm and Haas Co. v. Brotech Corp., 127 F.3d 1089, 1092, 44 USPQ2d 1459, 1462 (Fed. Cir. 1997) ("Nothing in the rules or in our jurisprudence requires the fact finder to credit the unsupported assertions of an expert witness."); cf. In re Alton, 76 F.3d 1168, 1174-75, 37 USPQ2d 1578, 1583 (Fed. Cir. 1996) (examiner's dismissal of declaration as offering an opinion was error since declaration offered factual evidence explaining why one of ordinary skill in the art would have understood the specification to describe the claimed subject matter).

In paragraph 15 of the Supplemental Declaration dated November 16, 1999, Dr. Kroto states:

Example 1 [in the specification] describes [a] product . . . in powder form as brownish-red. Such language connotes, in my opinion, that the product thereof could be seen with the naked eye. . . .

However, the fact that the product is in the form of a colored powder does not require the product to be macroscopic. As pointed out above, it is just as likely that the color of the powder was observed with the aid of a microscope as it is that the color of the powder was observed with the naked eye, especially since the original disclosure is silent as to whether the disclosed process produces a macroscopic amount of C₆₀.

Paragraph 15 of Dr. Kroto's Supplemental Declaration continues:

[B]ased upon repetition of the process described therein, as described hereinbelow, the process as described in the above-identified application, especially in Example 1, inherently produces fullerenes, e.g., C₆₀, in amounts that could be seen with the naked eye.

Appellants argue that this testimony establishes that the process described in their original disclosure inherently produces macroscopic amounts of C₆₀. See also paragraphs 17 through 19 of Dr. Kroto's Supplemental Declaration. Therefore, in accordance with the holding in In re Reynolds, 443 F.2d 384, 170 USPQ 94 (CCPA 1971), appellants argue that the original disclosure provides descriptive support for "macroscopic" amounts of C₆₀. See Brief, p. 29.

Specifically, appellants argue (Brief, p. 28):

In Reynolds the question was whether words describing a function that was inherent in the claimed product could be added to the specification by amendment, or whether such description was "new matter". The court cited with approval the holding in Technicon Instruments Corp. v. Coleman Instrument, Inc., 255 F.Supp. 630, 640-641, 150 USPQ 227, 236 (N.D. Ill. 1966), *affd*, 385 F.2d 391, 155 USPQ 369 (7th Cir. 1967), that: "By disclosing in a patent application a device that inherently performs a function, operates according to a theory, or has an advantage, a patent applicant necessarily discloses that function, theory, or advantage even though he says nothing concerning it." In re Reynolds, 433 F.2d at 389, 170 USPQ at 98. It was concluded that the express description of the inherent property, since not "new matter", could be added to the specification with effect as of the original filing date. Id.

"Inherency" was explained by the Court in Pingree v. Hull, 518 F.2d 624, 628, 186 USPQ 248, 251 (CCPA 1975) (citing Hansgirg v. Kemmer, 102 F.2d 212, 40 USPQ 665 (CCPA 1939)), as follows:

Inherency . . . may not be established by probabilities or possibilities. The mere fact that a certain thing *may* result from a given set of circumstances is not sufficient. [Citations omitted.] If, however, the disclosure is sufficient to show that the natural result flowing from the operation as taught would result in the performance of the questioned function, it seems to be well settled that the disclosure should be regarded as sufficient. [Underlining added.]

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See also Kooi v. DeWitt, 546 F.2d 403, 409, 192 USPQ 268, 273 (CCPA 1976) (for doctrine of inherency to provide support for DeWitt, he has the burden of showing that penetration of silicon oxide layer into silicon body inevitably occurs when the process steps are followed); cf. Kennecott Corp. v. Kyocera Int'l Inc., 835 F.2d 1419, 1423, 5 USPQ2d 1194, 1198 (Fed. Cir. 1987) ("necessary and only reasonable construction" standard for proving inherency to support a limitation in an interference count is consistent with other cases on the issue of compliance with section 112, first paragraph).

In this case, Dr. Kroto testified that he prepared macroscopic amounts of C₆₀ on numerous occasions since 1990 using the procedure described in appellants' application. See Supplemental Declaration dated November 16, 1999, ¶¶ 17-19. To the extent that Dr. Kroto's testimony establishes that macroscopic amounts of C₆₀ can be produced by the disclosed process, this testimony is not persuasive on the issue of inherency. Significantly, appellants' specification establishes that microscopic amounts of C₆₀ can also be produced using the same process. See, e.g., Specification, p. 3, lines 12-14 (Figure 3 shows an infrared absorption spectrum of an approximately 2 micrometer thick coating of the 98% C₆₀, 2% C₇₀ material on a silicon substrate); Specification, p. 3, lines 19-21 (Figure 4 shows a visible-ultraviolet absorption spectrum of an approximately 0.1 micrometer thick coating of the 98% C₆₀, 2% C₇₀ material on

quartz). Therefore, it cannot be said that the process described in appellants' originally filed application "inherently," i.e., inevitably or necessarily, produces "macroscopic" amounts of C₆₀.⁷

Finally, referring to page 35 of the Final Decision in Interference No. 103,281 (Paper No. 84), appellants argue that the board "held that the specification contained evidence that a product obtained from Example 1 was visible to the eye." Brief, p. 29. However, the product to which the board was referring is the "C₆₀-containing carbon dust," not the C₆₀ extracted from the carbon dust. In fact, the board expressly indicated that the "C₆₀-containing carbon dust" contains "an unidentified amount of C₆₀." See Paper No. 84, pp. 34-35.

For the reasons set forth above, the disclosure of appellants' application, as originally filed, does not provide descriptive support for preparing macroscopic amounts of C₆₀ using the claimed process. Therefore, the rejection of claims 45-49, 51-82, 96, 203 and 232 under 35 U.S.C. § 112, first paragraph, based on written description is affirmed.

2. Rejection under 35 U.S.C. § 112, first paragraph, based on enablement

Claims 45-49, 51-82, 96, 203 and 232 are rejected under 35 U.S.C. § 112, first paragraph, based on enablement. The examiner argues that the specification does not enable the production

⁷We note that the test for determining compliance with the written description requirement of 35 U.S.C. § 112, first paragraph, is whether the disclosure of the application as originally filed would have reasonably conveyed to one of ordinary skill in the art that the inventor had possession of the later claimed subject matter. Vas-Cath, 935 F.2d at 1563, 19 USPQ2d at 1116. Significantly, Dr. Kroto does not mention whether he prepared macroscopic amounts of C₆₀ using a process within the scope of the appealed claims. See Supplemental Declaration dated November 16, 1999, ¶¶ 17-19.

of macroscopic amounts of C₆₀ using the claimed process. According to the examiner (Paper No. 40, p. 4):

[T]he specification is not a commensurately enabling one, since the scope of the claims is broadened from the original disclosure, in that they now embrace formation and isolation of very large quantities of C₆₀, while original disclosure's literal language only supports product of C₆₀ quantities sufficient to produce 2-micron thick coatings.

There is no disclosure supporting or describing larger quantities of C₆₀ as are now embraced by the claims.

Appellants argue that the specification adequately teaches one skilled in the art how to make macroscopic amounts of C₆₀ without an undue amount of experimentation. See Brief, p. 31. For support, appellants rely on pages 3 through 7 of the specification and Example 1 as well as paragraphs 3 and 15 of the Kroto Declaration dated June 9, 1995, which state:

3. The application teaches in clear detail to the skilled artisan the preparation of fullerenes, including C₆₀, in quantities that were never recognizably achieved before the discovery of Huffman and Kratschmer described in the application. Specifically, the application describes methods for the production of C₆₀ and C₇₀ in macroscopic amounts, i.e., amounts that could be seen with the naked eye (inherently at least 10¹⁸ molecules of product). That discovery for the first time permitted the researchers to confirm the existence and structure of these materials, including subjecting them to general testing of their detailed properties and characteristics, which had theretofore only been projected based upon educated speculation and calculation, grounded upon circumstantial evidence of their existence.

* * * * *

15. In my professional judgment, the above-identified application adequately teaches to the skilled artisan how to make macroscopic amounts of the fullerenes including C₆₀ and C₇₀

Appellants' arguments are not persuasive. To satisfy the enablement requirement of 35 U.S.C. § 112, first paragraph, appellants' specification must teach one of ordinary skill in the art how to make and use the full scope of the claimed invention without undue experimentation.

In re Wright, 999 F.2d 1557, 1561, 27 USPQ2d 1510, 1513 (Fed. Cir. 1993). The claims on appeal are drawn to a process for preparing macroscopic amounts of C₆₀. However, for the reasons discussed above, appellants' original disclosure, including pages 3 through 7 of the specification and Example 1, does not describe, within the meaning of 35 U.S.C. § 112, first paragraph, that the claimed process produces macroscopic amounts of C₆₀. Appellants have failed to explain why the claims, which have a broader (or different) scope than appellants' original disclosure, are enabled by that disclosure. See In re Moore, 439 F.2d 1232, 1236, 169 USPQ 236, 239 (CCPA 1971) ("The relevant inquiry [for enablement under 35 U.S.C. §112, first paragraph,] may be summed up as being whether the scope of enablement provided to one of ordinary skill in the art by the disclosure is such as to be commensurate with the scope of protection sought by the claims.").

Furthermore, Dr. Kroto does not provide a factual basis for his opinion that appellants' application teaches the skilled artisan how to make macroscopic amounts of C₆₀. Therefore, the declaration fails in its purpose.⁸ See Brandstatter, 484 F.2d at 1406, 179 USPQ at 292 ("the

⁸We also note that Dr. Kroto does not discuss whether appellants' specification teaches one of ordinary skill in the art how to make macroscopic amounts of C₆₀ using the claimed process without undue experimentation. See Wright, 999 F.2d at 1561, 27 USPQ2d at 1513 (to (continued...)

affidavits fail in their purpose since they recite conclusions and few facts to buttress said conclusions"); see also Rohm and Haas, 127 F.3d at 1092, 44 USPQ2d at 1462 ("Nothing in the rules or in our jurisprudence requires the fact finder to credit the unsupported assertions of an expert witness.").

Appellants also direct our attention to paragraphs 8 and 15 through 19 of Dr. Kroto's Supplemental Declaration dated November 16, 1999. See Brief, p. 32. In that declaration, Dr. Kroto testifies as follows:

17. Utilizing the procedure exactly as described in the above-identified application, I have had fullerenes, including C₆₀, prepared in macroscopic amounts on numerous occasions since 1990 to the present. More specifically, by following the procedure described in the above-identified application and vaporizing graphite rods in an atmosphere of helium, forming the carbon soot therefrom, collecting the soot and dissolving the soot in benzene, in accordance with the procedure described in the above-identified application, I and my colleagues have prepared and identified various fullerenes, including, inter alia, C₆₀, C₇₀, C₇₆, C₇₈, C₈₄ and C₈₆.

18. Moreover, by following the procedure described in the above-identified application, and in accordance with the procedure outlined in Paragraph 17 herein, we have isolated fullerenes in macroscopic amounts, as defined herein. For example, utilizing the procedure outlined in Paragraph 17, I have found that the smoky carbon product contains 5 to 10% C₆₀ and 1% C₇₀. We routinely produce the soot in 1-5 gram quantities and routinely extract 100-500 milligram amounts batchwise. Thus, one kilogram of sooty carbon product produces, on average, 100g of C₆₀, 10g of C₇₀ and 1 gram of other fullerenes, such as those indicated hereinabove. The various fullerenes formed can and are isolated in accordance with the isolation and purification procedures described in the above-identified application, without an undue amount of experimentation. . . .

⁸(...continued)

be enabling, a specification must teach those skilled in the art how to make and use the full scope of the claimed invention without "undue experimentation").

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Dr. Kroto's supplemental declaration is not persuasive on the issue of enablement for two reasons. First, enablement is determined as of the effective filing date of an application.

Hybritech Inc. v. Monoclonal Antibodies, Inc., 802 F.2d 1367, 1384, 231 USPQ 81, 94 (Fed. Cir. 1986); see also Wright, 999 F.2d at 1562-63, 27 USPQ2d at 1514 (developments occurring after the effective filing date of Wright's application are of no significance regarding what one skilled in the art believed as of that date). In this case, the effective filing date of the application involved in this appeal, Application 08/236,933, is September 10, 1990.⁹

Dr. Kroto states that he prepared macroscopic amounts of fullerenes, including C₆₀, "on numerous occasions since 1990 to the present" using the procedure described in appellants' application. However, Dr. Kroto does not provide a date in 1990 for his earliest activities. Therefore, Dr. Kroto has not established that he prepared macroscopic amounts of C₆₀ earlier than the last day of 1990, i.e., December 31, 1990. Cf. Haultain v. DeWindt, 254 F.2d 141, 142, 117 USPQ 278, 279 (CCPA 1958) ("where testimony merely places the acts with a stated time period, the inventor has not established a date for his activities earlier than the last day of the period"). This date (December 31, 1990) is after appellants' effective filing date (September 10, 1990).

⁹According to appellants, Application 08/236,933 is a continuation of Application 07/855,959, filed March 23, 1992, now abandoned, which is a continuation of Application 07/781,549, filed October 22, 1991, now abandoned, which is a divisional of Application 07/580,246, filed September 10, 1990.

Second, Dr. Kroto states that "isolation and purification" of the fullerenes formed were performed without undue experimentation. However, the declaration is silent as to whether undue experimentation was required to produce the sooty carbon product from which the C₆₀ was "isolated and purified." See, e.g., claim 45 (the first step of the claimed process requires "vaporizing elemental carbon in the presence of an inert quenching gas under conditions effective to form a sooty carbon product comprising C₆₀ molecules . . ."). As explained above, to be enabling, a specification must teach those skilled in the art how to make and use the full scope of the claimed invention without "undue experimentation." Wright, 999 F.2d at 1561, 27 USPQ2d at 1513.

For the reasons set forth above, appellants have failed to establish that the specification enables, within the meaning of 35 U.S.C. § 112, first paragraph, the preparation of macroscopic amounts of C₆₀ using the claimed process. Therefore, the rejection of claims 45-49, 51-82, 96, 203 and 232 under 35 U.S.C. § 112, first paragraph, based on enablement, is affirmed.

3. Rejection under 35 U.S.C. § 112, second paragraph

Claims 83, 84 and 222 are rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicants regard as the invention. The examiner argues that in claims 83, 84 and 222 the scope of "amounts (or quantities) (of C₆₀) sufficient to be capable of producing a . . . colored solution

when extracted with sufficient (or effective) amounts of benzene" is unclear.¹⁰ Paper No. 40, p. 3.

Claims 83 and 84 read as follows:¹¹

83. A process for preparing C₆₀ comprising

(a) vaporizing elemental carbon in the presence of an inert quenching gas under conditions effective to form a sooty carbon product comprising C₆₀ molecules, said C₆₀ molecules being present in said sooty carbon product in amounts sufficient to be capable of providing a visibly colored solution when extracted with sufficient amounts of benzene and

(b) extracting C₆₀ from said sooty carbon product in amounts sufficient to provide a visibly colored solution when extracted with benzene in amounts sufficient to dissolve the C₆₀ present in said sooty carbon product.

84. A process for preparing C₆₀ comprising

(a) vaporizing elemental carbon in the presence of an inert quenching gas under conditions effective to provide a sooty carbon product comprising C₆₀ molecules, said C₆₀ molecules being present in said sooty carbon product in amounts sufficient to be capable of providing a visibly colored solution when extracted with benzene;

(b) depositing the sooty carbon product on a collecting surface;

(c) removing the sooty carbon product from the collecting surface; and

(d) extracting a product which is predominantly C₆₀ from said sooty carbon product, said C₆₀ being present in sufficient quantities to provide a visibly colored solution when extracted with benzene present in amounts sufficient to dissolve the C₆₀ present in said sooty carbon product.

¹⁰Claim 222 does not contain this language. Rather, claim 222 requires "C₆₀ being present in sufficient quantities to recover therefrom C₆₀ in amounts to be discernible as a colored solid." To the extent that the examiner's arguments apply to claim 222, the decision rendered herein also applies to claim 222.

¹¹We note that appellants incorrectly copied claims 83 and 84 in Appendix A of the appeal brief. A corrected copy of claims 83 and 84 has been reproduced in this Decision on Appeal.

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Specifically, the examiner argues that the claims are indefinite because it is unclear how much C₆₀ yields a colored solution. Answer, p. 4. We disagree. It is not necessary for the claims to recite a quantitative amount of C₆₀ in order to comply with the second paragraph of 35 U.S.C. § 112. The second paragraph of 35 U.S.C. § 112 merely requires one of ordinary skill in the art to understand the bounds of the claims when read in light of the specification. Miles Labs., Inc. v. Shandon Inc., 997 F.2d 870, 875, 27 USPQ2d 1123, 1126 (Fed. Cir. 1993), cert. denied, 510 U.S. 1100 (1994).

As explained by the Court in In re Moore, 439 F.2d 1232, 1235, 169 USPQ 236, 238 (CCPA 1971), the test for definiteness under 35 U.S.C. § 112, second paragraph, is:

[W]hether the claims do, in fact, set out and circumscribe a particular area with a reasonable degree of precision and particularity. It is here where the definiteness of the language employed must be analyzed—not in a vacuum, but always in light of the teachings of the prior art and of the particular application disclosure as it would be interpreted by one possessing the ordinary level of skill in the pertinent art.

In this case, appellants have chosen to define the amount of C₆₀ present in the sooty carbon product as an amount "sufficient to be capable of providing a visibly colored solution" when extracted with benzene.

However, the examiner argues that the intensity of the color in the "visibly colored solution" is unclear, and the "visibly colored solution" is not defined by "transmission at a certain wavelength." Answer, p. 4.

Clearly, one of ordinary skill in the art would understand the bounds of a "visibly colored solution" when read in light of the specification. As explained by appellants, "the test is color

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versus no color, i.e., something which is easily determinable and discernible . . ." Brief, p. 20.

See Specification, p. 7, lines 11-12 ("the sooty product is treated with benzene to provide a brownish-red solution"); Specification, p. 16, lines 18-20 (C_{60} -containing carbon dust samples were extracted with benzene to produce a wine-red to brown solution).

Furthermore, the fact that appellants have not limited the color of the solution to a specific wavelength does not render the claims indefinite. The claims are merely broad in this respect, covering a colored solution of any wavelength in the visible spectrum. Significantly, breadth is not indefiniteness. In re Gardner, 427 F.2d 786, 788, 166 USPQ 138, 140 (CCPA 1970).

The examiner further contends that "the perception of color lies, literally, in the eye of the beholder" and points out that there are individuals who have impaired color perception. Answer, p. 4. As explained above, the test for definiteness is whether the hypothetical person of ordinary skill in the art understands the metes and bounds of the claims when read in light of the specification, not whether a specific individual can perceive the "visibly colored" solution claimed.

The examiner also argues that if the sample is not pure, contaminants, rather than C_{60} , could cause the solution's color. Answer, p. 4. This argument is not persuasive. The claims are directed to the amount of C_{60} that provides a visibly colored solution when extracted with sufficient amounts of benzene regardless of whether contaminants are present.

Finally, the examiner argues that the use of the word "capable" in the claims adds further confusion as to their scope. Specifically, the examiner questions whether the claims actually

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require a colored solution, and if so, argues that it is unclear what steps are necessary to produce the colored solution. See Answer, pp. 4-5.

We disagree. Although not a model of clarity, claims 83 and 84 do require the formation of a "visibly colored solution" in the extracting step, i.e., when a sufficient amount of C₆₀ is extracted from the sooty carbon product with a sufficient amount of benzene to dissolve the C₆₀, a visibly colored solution is produced. See Specification, p. 16, lines 18-21 (C₆₀ is extracted from the sooty carbon product by dissolving a sufficient amount of C₆₀ in benzene to produce a wine-red to brown solution; on evaporation of the solution, C₆₀ is obtained as a microcrystalline residue); see also Specification, p. 5, lines 18-26.

For the reasons set forth above, the rejection of claims 83, 84 and 222 under 35 U.S.C. § 112, second paragraph, is reversed.

Conclusion

The rejection of claims 83, 84 and 222 under 35 U.S.C. § 112, second paragraph, is reversed. The rejection of claims 45-49, 51-82, 96, 203 and 232 under 35 U.S.C. § 112, first paragraph, based on written description, is affirmed. The rejection of claims 45-49, 51-82, 96, 203 and 232 under 35 U.S.C. § 112, first paragraph, based on enablement, is affirmed.

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No time period for taking any subsequent action in connection with this appeal may be extended under 37 CFR § 1.136(a) (2004).

AFFIRMED-IN-PART; REVERSED-IN-PART

Edward C. Kimlin

EDWARD C. KIMLIN
Administrative Patent Judge

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M

- M.** (1) Symbol for metal. (2) Abbreviation for mega, or million. **M acid.** 1-Amino-5-naphthol-4-sulfonic acid.
- M.** Symbol for: (1) mass, (2) molal, (3) molecular weight, (4) the mathematical constant $\log_e 10 = 0.43429,44819$. M^{-1} The mathematical constant $\log_e 10 = 2.30258,50930$. **M electron.** The electron of the *M* shell or *M* orbit, q.v. **M orbit.** The third layer or energy level, in which electrons move around the proton in the dynamic atom. **M. radiation.** A series of homogeneous X rays characteristic of the metal used as anticathode, and fainter than the *K* and *L* series. **M series.** The spectral lines produced by the *M* radiations on diffraction through a crystal grating. Cf. *Moseley spectra*. **M shell.** The third layer or energy level, in which electrons oscillate in the static atom.
- m.** Abbreviation for: (1) meter, (2) milli-, or one-thousandth part. **m².** Abbreviation for square meter. **m³.** Abbreviation for cubic meter. Cf. *mm*, *mmm*.
- m.** Symbol for: (1) meta position, (2) metastable state.
- ℳ.** Abbreviation for minim.
- μ.** Greek mu. (1) Abbreviation for: (a) micron, (b) micro-, or one-millionth of a unit. (2) Symbol for: (a) meso position, (b) magnetic permeability. Cf. *mμ*, *μμ*.
- Ma.** Symbol for masurium.
- ma.** Abbreviation for milliampere.
- Mac.** See also *Mc*.
- macassar oil.** Yellow fat from the seeds of *Schleichera trijuga*, India and Malaysia.
- mace.** Macis. The dried covering tissues of the seeds of *Myristica fragrans*; a condiment. **m. oil.** An essential oil from mace. Colorless liquid, d.0.91; a flavoring.
- macene.** $C_{10}H_{18} = 138.1$. A terpene from mace oil.
- maceral.** General name for the microscopic structures of the mineral constituents of coals.
- macerate.** To break up a solid by soaking in a liquid.
- Mache, Heinrich.** Austrian physicist. born, 1876.
- m. unit.** M.E. The quantity of radioactive emanation which produces a saturation current of one-thousandth of an electrostatic unit. 1 curie = 2.8×10^9 maches. 1 mache = 3.64×10^{-10} curie/liter = 3.64 eman.
- machine steel.** A steel containing less than 0.3% carbon; easily machined.
- macht metal.** A forging alloy containing Cu 60, Zn 38, Fe 2%.
- Mach unit.** A unit of velocity, expressed as a percentage of the velocity of sound at sea level.
- mackay bean.** The dried seeds of *Entada scandens* (Leguminosae), Queensland; a coffee substitute.
- mackenite metals.** A group of heat-resisting Ni-Cr or Ni-Cr-Fe alloys.
- Mackenzie amalgam.** An amalgam made by grinding together the solid alloys Hg-Bi and Pb-Hg.
- Mackey test.** A test of the autoxidation fire hazards of oils.
- maclayine.** $C_{17}H_{32}O_{11} = 412.26$. An alkaloid from *Illicope maclayana* (Sapotaceae), the tropics.
- macle.** (1) A variety of andalusite. (2) A twin crystal.
- MacLeod, John James Rickard.** 1876-1935. Scottish-Canadian biochemist, awarded Nobel Prize (with Banting) in 1923 for share in discovery of insulin.
- macleyine.** Protopine.
- maclurin.** $C_6H_3(OH)_2CO.C_6H_2(OH)_3 = 280.1$. Pentahydroxybenzophenone, osage orange (q.v.), moringatannic acid. Yellow crystals from the wood of *Maclura aurantiaca*, m.200, soluble in hot water; a dye.
- macro-** Prefix (Greek *μακρός* = broad), indicating "large."
- macroaxis.** The long axis in orthorhombic or triclinic crystals.
- macrobacterium.** A large bacterium.
- macrocarpene.** An alkaloid from *Thalictrum macrocarpum* (Ranunculaceae). Yellow crystals, soluble in water.
- macrochemistry.** (1) The chemistry of reactions that are visible to the unaided eye. Cf. *microchemistry*. (2) Chemical operations on a large scale.
- macrocyclic.** Containing rings of more than 7 C atoms.
- macrodome.** See *dome*.
- macrofarad.** Megafarad.
- macrograph.** Photomacograph.
- macrolide.** A substance having a macrocyclic lactone structure; as, streptomycin.
- macromolecular chemistry.** The study of the preparation, properties, and uses of substances containing large and complex molecules: i.e., mol. wt. exceeding 1,000. Cf. *polymer*.
- macroscopic.** Describing objects visible to the naked eye. Cf. *microscopic*.
- macrotin.** Cumicifugin.
- macrotoid.** The combined principles from the root of *Cimicifuga racemosa*; an antispasmodic.
- macrotyne.** Cimicifuga.
- maculanin.** Potassium amylate.
- madder.** Turkey red, q.v. Garance. The root of *Rubia tinctorum* species. It contains glucosides which yield, on fermentation, alizarin and purpurin; a dye and pigment in lakes.
- Maddrell salt.** A long-chain, high-molecular-weight sodium metaphosphate, made by heating sodium metaphosphate at 300; soluble in potassium salt solutions.
- mafic.** A rock-forming material, mainly magnesium and iron silicates.
- mafurite.** A mineral association of kieserite and augite, q.v.

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Mackenzie Bay on the Beaufort Sea, a part of the Arctic Ocean. **Mac-ken-zie** (mā-kēn'zē). Sir Alexander. 1764-1820. Scottish explorer of the Canadian northwest.

mack-er-el (māk'ər-əl, māk'ərl) n., pl. **mackerel** or **-els**. 1. Any of several marine fishes of the family Scombridae, found worldwide. Some species are important food fishes, especially the Atlantic mackerel, *Scomber scombrus*, which has dark, wavy bars on the back and a silvery belly. 2. Any of the smaller fishes of the suborder Scombroidea, such as the Spanish mackerel (*see*). 3. Any of various fishes resembling mackerel. [Middle English *makerel*, from Old French *maquerel*.]

mackerel sky. A formation of cirrocumulus or altocumulus clouds suggesting the bars on a mackerel's back.

Mack-i-nac (māk'i-nāc). An island in Michigan on the Lake Huron side of the Straits of Mackinac. Population, 11,000. [Canadian French, short for *Michilimackinac*, from early Ojibwa *Mišilimaaahkinaank*, "at the territory of the Mishinimaki" (an extinct division of the Ojibwa formerly living there).]

Mack-i-nac, Straits of (māk'i-nō'). A channel between Michigan's Upper and Lower peninsulas.

mack-i-naw (māk'i-nō') n. 1. A short, double-breasted coat of heavy woolen material, usually plaid. 2. The cloth from which such a coat is made, usually of wool, often with a heavy nap. [From MACKINAC (the cloth and the coat were trading items through the entrepôt on the island in the 19th century).]

Mackinaw blanket. A thick blanket in solid colors or stripes, formerly used in northern and western North America by Indians, traders, and trappers.

Mackinaw boat. A flat-bottomed boat formerly common in the upper Great Lakes area.

Mackinaw trout (*see*).

mack-in-tosh (māk'in-tōsh') n. Also **mac-in-tosh**. Chiefly British. **Obsolete**. a. A raincoat of patented rubberized cloth. b. This cloth. 2. Any raincoat. Also informally called "mac." [Invented by Charles Macintosh (1766-1843), Scottish chemist.]

mack-le (māk'əl) n. Also **mac-u-le** (māk'yōōl). **Printing**. A spot, especially blurred or double impression caused by a slipping of the type or wrinkle in the paper. —v. **mackled**, **-ling**, **-les**. Also **mac-u-le**, **-uled**, **-uling**, **-ules**. —tr. To blur or double (a printed impression). —intr. To become blurred. [French *macule*, from Latin *macula*, spot. See *macula* in Appendix.*]

mac-le (māk'əl) n. 1. A mineral, chalcocite (*see*). 2. A crystalline form, twin (*see*). 3. A spot or discoloration in a mineral. [French, double crystal, from Old French *macle*, heraldic term for a "voided lozenge" (one diamond shape within another), originally a stylized mesh of a net; from Latin *macula*, mesh, hole in a net, spot. See *macula* in Appendix.*]

Mac-Leish (māk-lēsh'). Archibald. Born 1892. American poet, dramatist, and Librarian of Congress.

Mac-leod (māk-lōd'). John James Rickard. 1876-1935. Scottish physiologist; participated in development of insulin.

Mac-Mill-an (māk-mīl'ān). Donald Baxter. 1874-1970. American Arctic explorer; first to use aircraft in exploration.

Mac-mill-an (māk-mīl'ān). (Maurice) Harold. Born 1894. Prime minister of the United Kingdom (1957-63).

Ma-con (māk'ən). A city and industrial center of Georgia, 78 miles southeast of Atlanta. Population, 122,000.

Mac-pher-son (māk-für'sən). James. 1736-1796. Scottish poet and historian; self-proclaimed translator of *Ossian* (*see*).

Mac-quar-ie (māk'kwōr'ē). 1. A river in New South Wales, Australia, flowing 590 miles from the Blue Mountains to the Darling River. 2. A group of small islands in the South Pacific, some 800 miles southeast of Tasmania, Australia.

mac-ra-mé (māk'rā-mē'). Coarse lacework made by weaving and knotting cords into a pattern, used as a fringe or trimming for furniture. [French, from Italian *macramè*, from Turkish *makrama*, napkin, towel, from Arabic *magramah*, striped cloth.]

mac-ren-ceph-a-ly (māk'ren-sēf'ə-lē) n. Also **mac-ren-ce-phali-a** (-sā-fā'lē-ə). **Pathology**. Abnormal enlargement of the brain. [MACR(O)- + ENCEPHAL(O) + -LY.]

macro-, **macr-**. Indicates: 1. largeness or longness in extent, duration, or size; for example, *macronucleus*. 2. Abnormal largeness or overdevelopment, especially in some part; for example, *macronecephaly*. Compare *micro-*. [From Greek *makros*, large, long. See *mák-* in Appendix.*]

macro-bi-o-sis (māk'rō-bi-ō'sis) n. Longevity. [Late Greek *makrobiosis*: MACRO- + -BIOSIS.]

macro-bi-o-ics (māk'rō-bi-ō'iks) n. Plural in form, used with a singular verb. 1. The theory or practice of promoting longevity. 2. A method purporting to promote longevity, principally by means of diet. [Greek *makrobiots*, long-lived : MACRO- + *biots*, life (see *biotin*) + -ICS.] —**macro-bi-otic** adj.

macro-ceph-a-ly (māk'rō-sēf'ə-lē) n. Also **macro-ce-phali-a** (-sā-fā'lē-ə). **Pathology**. Abnormally large cranial capacity, often observed in the mentally retarded. Also called "megacephaly," "megaloccephaly." [French *macrocéphale*, from *macrocéphale*, having a long head, from Greek *makrokephalos*: MACRO- + -CEPHALOUS.] —**macro-ce-phali'a** (-sā-fā'līk). **macro-cephalous** adj.

macro-chem-is-try (māk'rō-kēm'is-trē) n. Chemistry requiring neither microscopy nor microanalysis. Compare *microchemistry*. —**macro-chem'i-cal** adj.

macro-cli-mate (māk'rō-kli'mit) n. **Meteorology**. The climate of a large geographical area. Compare *microclimate*. —**macro-climatic** (-kli-māt'ik) adj.

macro-cosm (māk'rō-kōz'əm) n. 1. The universe itself, or the concept of universe. 2. A system regarded as an entity containing subsystems. Compare *microcosm*. [French *macrocosme*, from Medieval Latin *macrocosmus*, from Late Greek *makros*

Mackenzie

kosmos, the great world : MACRO- + *kosmos*, world (see *kosmos* in Appendix*). —**macro-cosmic** adj.

mac-ro-cy-te (māk'rō-sīt') n. **Pathology**. An abnormally large red blood cell associated with some forms of anemia. [MACRO- + (ERYTHRO)CYTE.] —**macrocytic** (-sīt'ik) adj.

mac-ro-cy-to-sis (māk'rō-sī-tō'sis) n. **Pathology**. A condition in which the blood contains macrocytes. —**macrocytotic** (-tōt'ik) adj.

mac-ro-evo-lu-tion (māk'rō-ēvō-lōshōn) n. Evolution involving whole species, or larger groups, of organisms. —**macroevolutionary** adj.

mac-ro-ga-mete (māk'rō-gō-mēt', -gām'ēt') n. **Biology**. The larger of two conjugating cells, usually female, in protozoans. Compare *micrometame*.

mac-ro-graph (māk'rō-grāf', -grāf') n. A representation of an object at least as large as the object. [MACRO- + -GRAPH.]

mac-rogr-a-phy (māk'rōgrāf'ē) n. 1. Examination of objects with the unaided eye. Compare *micrography*. 2. Abnormally large handwriting, sometimes indicating a nervous disorder. [MACRO- + -GRAPHY.]

mac-ro-mo-le-cule (māk'rō-mōl'ē-kyoōl') n. 1. A polymer, especially one composed of more than 100 repeated monomers. 2. Any crystal, such as diamond or common salt, in which individual atoms or molecules cannot be distinguished.

ma-cron (māk'rōn', -krōn) n. 1. A diacritical mark placed above a vowel to indicate a long sound or phonetic value in pronunciation, such as (ā) in the word *make*. Compare *breve*. 2. The horizontal mark (—) used to indicate a stressed or long syllable in a foot of verse. [Greek *makron*, neuter of *makros*, long. See *mák-* in Appendix.*]

mac-ro-nu-cle-us (māk'rō-nōō'klē-əs) n., pl. **-clei** (-klē-ē). 1. A large, trophic, nonreproductive nucleus in the cells of ciliated protozoans. Compare *micronucleus*.

mac-ro-nu-tri-ent (māk'rō-nōō'trē-ənt) n. **Botany**. An element, such as carbon, hydrogen, oxygen, or nitrogen, required in large proportion for the growth and development of plants.

mac-ro-phys-i-cs (māk'rō-fiz'iks) n. Plural in form, used with a singular verb. The physics of macroscopic phenomena.

ma-crop-ter-ous (māk'rō-pär'tar-əs) adj. **Zoology**. Having unusually large fins or wings. [Greek *makropteros*: MACRO- + -PTEROUS.]

mac-ro-scop-i-cic (māk'rō-skōp'ik) adj. Also **macroscop-i-cal** (-i-kəl). 1. Large enough to be perceived or examined without instrumentation, especially as by the unaided eye. 2. Pertaining to observations made without magnifying instruments, especially as by the unaided eye. Also "megascopic." [MACRO- + -SCOP(Y) + -IC.] —**macroscop'i-cally** adv.

mac-ro-spo-ram-i-gum (māk'rō-spo-rāñ'jē-əm) n., pl. **-gia** (-jē-ə). Botany. A megasporangium (*see*).

mac-ro-spo-re (māk'rō-spōr', -spōr') n. Botany. A megasporangium (*see*).

mac-u-la (māk'yōōl-ə) n., pl. **-lae** (-lē). 1. A spot, stain, blemish, or pit; especially, a discoloration of the skin caused by excess or lack of pigment. 2. A sunspot. [Latin *macula*, spot, blemish. See *macula* in Appendix.*] —**mac-u-lar** (-lär) adj.

macula lu-te-a (lūtō-tē-ə) pl. **maculae luteae** (lūtō-tē-ē). Anatomy. An area in the eye near the center of the retina at which visual perception is most acute. [New Latin, "yellow spot."]

mac-u-late (māk'yōō-lāt') tr.v. **-lated**, **-lating**, **-lates**. To spot, blemish, or pollute. —adj. (māk'yā-lit). 1. Spotted or blotched. 2. Stained; impure. [Middle English *maculaten*, to stain, from Latin *maculare*, from *macula*, spot, blemish. See *macula* in Appendix.*]

mac-u-lation (māk'yōō-lāshōn) n. 1. The act of spotting or staining. 2. A spotted or stained condition. 3. The spotted markings of a plant or animal, such as the spots of the leopard.

mac-u-le (māk'yōōl) v. **-uled**, **-uling**, **-ules**. —tr. To blur; mackle. —intr. To become blurred or mackled. —n. **Printing**. Variant of *mackle*. [Middle English, from Old French, from Latin *macula*, spot, blemish. See *macula* in Appendix.*]

mad (mād) adj. **madder**, **maddest**. 1. Suffering from a disorder of the mind; insane: *"Honora was eccentric, but Maggie told everyone in the village that she was mad."* (John Cheever). 2. As if insane; temporarily or apparently deranged by violent sensations, emotions, or ideas: *"I tell thee I am mad / In Cressid's love."* (Shakespeare). 3. **Informal**. Feeling or showing strong liking or enthusiasm. Used with about, for, or over: *"You probably know how mad he is about sports."* (Peter Taylor). 4. **Informal**. Angry; resentful: *"He'd be so mad he missed it he wouldn't speak to me for days."* (Harper Lee). 5. Lacking restraint or reason; wildly foolish; senseless: *"Ah, will you stop telling me your mad dreams."* (Eugene O'Neill). 6. Marked by extreme excitement, confusion, or agitation; frantic: *a mad scramble for the bus.* 7. Boisterously gay; hilarious: *have a mad time*. 8. **Slang**. Delightfully unusual; humorously pointless: *mad conversation in double talk.* 9. Affected by rabies; rabid. —have a mad on. **Slang**. To sulk; be angry. —like mad. **Slang**. Wildly; impetuously: *He drove like mad.* —v. **madded**, **madding**. **mads**. —tr. **Rare**. To madden or make mad. —intr. **Rare**. To act, be, or become mad. [Middle English *madd*, Old English *gemædd*, past participle of *gemædan*, to madden, from *gemad*, mad. See *mei-* in Appendix.*]

MAD Airport code for Madrid, Spain.

Mad-a-gas-car (mād'ə-gās'kar). The fourth-largest island (227,602 square miles) in the world. Lying in the Indian Ocean, about 250 miles off the southeastern coast of Africa, it is coextensive with the Malagasy Republic.

Madagascar periwinkle. A plant, *Vinca rosea*, native to Madagascar, having pink or white flowers.

Madagascar periwinkle



mackerel
Scomber scombrus
Atlantic mackerel



Archibald MacLeish



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